APPENDIX H

Memorandum

**U.S. Department
of Transportation**

**Federal Highway
Administration**

Subject: **ACTION:** Exemption Criteria During Highway Sanctions   Date: March 11, 1996

From: Rodney E. Slater
Administrator

Reply to
Attn. of: HEP-40

To: Regional Administrators
Federal Lands Highway Program Administrator

This policy memorandum defines the exemption criteria that will be used to determine which projects can go forward and which grants can be awarded in the event EPA imposes highway sanctions under Section 179(a) or Section 110(m) of the CAA. This policy memorandum contains a description of the criteria for exemptions and clarification of the types of projects and programs that are exempt. Projects for which exemptions cannot be granted are also included in this policy memorandum.

General Description

Highway sanctions, when applied, halt the approval of projects and the award of any grants funded under Title 23, U.S.C., except as defined in Section 179(b) and as clarified by this policy memorandum. This applies to the following major funding programs:

1. Surface Transportation Program (STP).
2. National Highway System.
3. Interstate Maintenance.
4. Bridges.
5. Interstate Construction.
6. Interstate Substitution.
7. Congestion Mitigation and Air Quality Improvement Program (CMAQ).

Projects funded under all other Title 23 programs and other authorizations are also subject to sanctions, including demonstration projects identified by Congress and specified in the ISTEA of 1991 under Sections 1103-1108 or in other laws, unless they meet the criteria set forth in this policy memorandum. Additionally, other Title 23 projects to be funded under previously authorized programs (prior to passage of the ISTEA, such as the Federal-aid Urban, Federal-aid Secondary Programs, etc.) may also be subject to certain highway funding restrictions under highway sanctions.

Projects funded under Title 49, U.S.C. chapter 53, the Federal Transit Act, as amended, are categorically exempt from sanctions by law as are other transportation programs authorized by statutes other than Title 23.

Typical Nonexempt Projects

The following types of projects generally do not meet the exemption criteria in Section 179(b)(1) and would not be allowed to be federally funded or approved under Title 23 unless it is demonstrated that they meet one or more of the exemption criteria. These include projects that expand highway or road capacity, nonexempt project development activities, and any other project that does not explicitly meet the criteria in this policy memorandum. These may include activities for:

1. The addition of general purpose through lanes to existing roads.
2. New highway facilities on new locations.
3. New interchanges on existing highways.
4. Improvements to, or reconfiguration of existing interchanges.
5. Additions of new access points to the existing road network.
6. Increasing functional capacity of the facility.
7. Relocating existing highway facilities.
8. Repaving or resurfacing except for safety purposes, as defined by section 179(b).
9. Project development activities, including NEPA documentation and preliminary engineering, right-of-way purchase, equipment purchase, and construction solely for non-exempt projects.
10. Transportation enhancement activities associated with the rehabilitation and operation of historic transportation buildings, structures, or facilities not categorically exempted.

Project Exemptions

Under Section 179(b)(1) of the CAA, once EPA imposes highway sanctions, the FHWA may not approve or award any grants in the sanctioned area except those which generally meet the criteria within this memoradum. Congress specifically exempted projects which fall under three categories: (1) safety programs and projects (under Section 179(b)(1)(A)); (2) seven congressionally-authorized activities (under Section 179(b)(1)(B)(i-vii)); and, (3) air quality improvement projects that would not encourage single occupant vehicle (SOV) capacity (under Section 179(b)(1)(B)(viii) of the CAA). This policy memorandum further interprets and clarifies these statutory exemption provisions.

1. Safety Programs and Projects
   Safety projects are those for which the principal purpose is an improvement in safety but the projects may also have other important benefits. These projects must resolve a

demonstrated safety problem with the likely result being a significant reduction in or avoidance of accidents as determined by the FHWA. Such demonstration must be supported by accident or other data submitted by the State or appropriate local government.

Four general types of categories of safety-based programs and projects potentially meet the exemption criteria: grant programs and related activities; Emergency Relief (ER) projects; statewide safety improvement programs; and specific projects outside of a statewide safety program. Each category calls for varying levels of justification.

a. Programs administered by NHTSA qualify for blanket exemptions, on the basis that their principal purpose is to improve safety and do not include any capital improvements. Programs that fall within this category include but are not limited to: (1) Use Safety Belts and Motorcycle Helmets (23 U.S.C. 153); (2) Highway Safety Programs (23 U.S.C. 402); (3) Highway Safety Research and Development (23 U.S.C. 403); and (4) Alcohol-Impaired Driving Countermeasures (23 U.S.C. 410).

b. The ER projects funded by Title 23 to repair facilities damaged or destroyed by natural disasters, civil unrest, or terrorist acts are exempt without further justification, provided that such projects do not involve substantial functional, locational, or capacity changes.

c. Statewide safety improvement programs include specific safety projects that can be justified on the basis of State or national level data, which will be additionally supported by data and analysis stemming from the State (or ISTEA) management system requirements once the systems are fully operational. Projects meeting this exemption category would come out of the Highway Safety Improvement Program (23 CFR Part 924) and the Highway Bridge Replacement and Rehabilitation Program (23 CFR Part 650, Subpart D). The Highway Safety Improvement Program also includes the Hazard Elimination Program (23 U.S.C. 152).

d. Specific projects for which justification is needed to show that the project is related to safety, unless the project is drawn out of a statewide safety program and would be likely to reduce accidents, would include capital projects such as:

- Elimination of, and safety features for, railroad-highway grade crossings.
- Changes in vertical or horizontal alignment.
- Increasing sight distance.
- Elimination of high hazard locations or roadside obstacles.
- Shoulder improvements, widening narrow pavements.
- Adding or upgrading guardrail, medians and barriers, crash cushions, fencing.
- Pavement resurfacing or rehabilitation to improve skid resistance.
- Replacement or rehabilitation of unsafe bridges.
- Safety roadside rest areas, truck size and weight inspection stations.

- Addition and upgrading of traffic control devices, (traffic signals, signs, and pavement markings).
- Lighting improvements.
- Truck climbing lanes.

Justification for an exemption on the grounds of safety must be based on accident or other data such as the data derived from a State's safety and bridge management system, the Highway Safety Improvement Program, or the Highway Bridge Replacement and Rehabilitation Program. Such data need not be specific to the proposed project's location, but may be based on accident or other data from similar conditions, including national experience where such projects have been implemented to remove safety hazards. For example, rigid highway sign posts were identified in the past as a safety hazard causing unnecessary deaths and injuries. The identification of this hazard led to national policy requiring rigid posts to be replaced with breakaway poles.

Projects exempted under the safety provision may not involve substantial functional (such as upgrading major arterial to freeways), locational, or capacity changes except when the safety problem could not otherwise be solved.

2. Congressionally Authorized Activities
    Seven project types are identified specifically in the CAA section 179(b)(1) as exempt from highway sanctions. Essentially, these are projects that generally do not result in increased SOV capacity, or improve traffic flow (e.g., intersection improvements or turning lanes) in ways that reduce congestion and emissions:

    a. Capital programs for public transit. These include any capital investment for new construction, rehabilitation, replacement, or reconstruction of facilities and acquisition of vehicles and equipment.
    b. Construction or restriction of certain roads or lanes solely for the use of passenger buses or High Occupancy Vehicles (HOV). Exempt projects include construction of (or conversion of existing lanes to) new HOV lanes, if those lanes are solely dedicated as 24-hour HOV facilities.
    c. Planning for requirements for employers to reduce employee work-trip related vehicle emissions. This includes promotional and other activities associated with this type of program that are eligible under Title 23.
    d. Highway ramp metering, traffic signalization, and related programs that improve traffic flow and achieve a net emission reduction.
    e. Fringe and transportation corridor parking facilities serving multiple occupancy vehicle programs or transit operations (this includes the construction of new facilities and the maintenance of existing facilities).

f.   Programs to limit or restrict vehicle use in downtown areas or other areas of emission concentration, particularly during periods of peak use, through road use charges, tolls, parking surcharges, or other pricing mechanisms, vehicle restricted zones or periods, or vehicle registration programs. Exempt projects include all activities of these types that are eligible under existing funding programs.

g.   Programs for breakdown and accident scene management, non-recurring congestion, and vehicle information systems, to reduce congestion and emissions.

The FHWA will consult with EPA on any project claimed to reduce emissions (e.g., with projects falling under paragraphs c, d, and g above). However, the final authority to determine whether a project meets the criteria in this memorandum and is exempt from highway sanctions rests with the FHWA.

3.   Air Quality Improvement Programs that Do Not Encourage SOV Capacity Transportation programs not otherwise exempt that improve air quality and which would not encourage SOV capacity (as determined by EPA in consultation with DOT) are also exempt from highway sanctions. For example, projects listed in section 108(f) of the CAA and projects funded under 23 U.S.C. 149, the CMAQ program, are projects which EPA and DOT may, after individual review of each project, find to be exempt from highway sanctions. For these projects to advance while highway sanctions are in place, the State must submit to DOT an emissions reduction analysis similar to that required under the CMAQ program. Upon receipt, DOT will forward it to EPA. The EPA will complete its review and make its finding regarding air quality and SOV capacity within 14 days of receipt of such information.

The EPA and DOT have agreed that the following projects will be categorically exempt from highway sanctions, and will not require additional EPA review or an individual finding by EPA:

a.   The TCMs contained in an EPA-approved SIP or FIP which have emission reduction credit and will not encourage SOV capacity.

b.   I/M facilities and activities eligible for CMAQ funding.

c.   Bicycle and pedestrian facilities and programs.

d.   Carpool/Vanpool programs.

e.   Conversion of existing lanes for HOV use during peak-hour periods, including capital costs necessary to restrict existing lanes (barriers, striping, signage, etc.).

In considering exempt projects, States should seek to ensure adequate access to downtown and other commercial and residential areas, and should strive to avoid increasing or relocating emissions and congestion.

4. **Projects That Have a "De Minimis" Air Quality Impact and Provide Other Environmental or Aesthetic Benefits**

    The following projects are likely to have "de minimis" environmental or environmentally beneficial impacts, provide other aesthetic benefits, do not promote SOV capacity, and are, therefore considered exempt from highway sanctions:

    a. Wetland Mitigation.
    b. Planting Trees, Shrubs, Wildflowers.
    c. Landscaping.
    d. Purchase of Scenic Easements.
    e. Billboard and Other Sign Removal.
    f. Historic Preservation.
    g. Transportation Enhancement Activities (except rehabilitation and operation of historic transportation buildings, structures, or facilities).
    h. Noise Abatement.

Planning and Research Activities: Planning and research activities for transportation and/or air quality purposes are exempt from highway sanctions (except as noted in the **Project Development Activities** section). Such planning and research is critical for the development of projects that improve safety and address an area's transportation/air quality needs. Planning and research activities may include development of an Environmental Impact Study or Environmental Assessment (under NEPA) in conjunction with a major investment study. Major investment studies are planning studies which normally take a multimodal approach in considering transportation alternatives, and are therefore exempt from sanctions under this criteria.

Research activities also include those research, development, testing, and planning projects involving the National Intelligent Transportation Systems (ITS) Program funded by Part B of Title 6 of the 1991 ISTEA. The goal of the ITS Program is to use advanced technology to improve travel and roadway safety without expanding existing infrastructure. The ITS activities are generally done under seven broad categories: (1) transportation management and traveller information; (2) travel demand management; (3) public transportation operations; (4) electronic payment; (5) commercial vehicle operations; (6) emergency management; and (7) advanced vehicle control and safety systems. Therefore, planning and research activities associated with the ITS Program are also exempt from sanctions under this criteria.

Project Development Activities: Development and completion of studies to meet requirements under NEPA are exempt from highway sanctions as long as consideration of projects that would be exempt under this policy memorandum, such as transit or other Transportation Demand Management (TDM) measures, are actively pursued as reasonable independent alternatives. Once all alternatives that could be considered exempt from highway sanctions under this policy memorandum are eliminated, project development activities for NEPA or other purposes are no longer exempt and can no longer be

approved or funded under Title 23. For example, if prior to completion of NEPA documentation, all TDM measures are eliminated from consideration and the sole remaining question is the determination of an alignment for a highway capacity-expanding project (which may include TDM), subsequent project development activities are not exempt from highway sanctions.

The FHWA may not approve preliminary engineering for final design of a project, nor can approval be granted for a project's plans, specifications, and estimates after initiation of highway sanctions for projects that are not exempt under this policy memorandum. Neither right-of-way nor any necessary equipment may be purchased or leased with Federal funds for nonexempt projects while an area is under sanction. Federally-funded construction may not in any way begin on a project that does not meet the exemption criteria described in this policy memorandum while an area is under sanction.

Highway sanctions apply to those projects whose funds have not yet been obligated by FHWA by the date the highway sanction applies. Those projects that have already received approval to proceed and had obligated funds before EPA imposes the prohibition may proceed even while the area is under sanction, if no other FHWA action is required to proceed. In the case of a phased project, only those phases that have been approved and had obligated funds prior to the date of sanction application may proceed. For example, if preliminary engineering for a project was approved and funds were obligated prior to application of sanctions, but no approval was secured for later project phases (such as right-of-way acquisition, construction, etc.), preliminary engineering could proceed while the highway sanction applies, but no subsequent phases of the project could proceed with FHWA funds unless the total project meets the exemption criteria in this policy memorandum. These restrictions pertain only to project development activities that are to be approved or funded by FHWA under Title 23. Activities funded under Title 49, U.S.C., or through State or other funds, may proceed even after highway sanctions have been imposed unless: (1) approval or action by FHWA under Title 23 is required; and (2) they do not meet the exemption criteria of this policy memorandum.

Other Environmental Requirements

Exemption of a transportation project from Section 179(b)(1) highway sanctions does not waive any applicable requirements under NEPA (e.g., environmental documents), section 176(c) of the CAA (conformity requirement), or other Federal law.

Memorandum

U.S. Department
of Transportation

**Federal Highway
Administration**

Subject: Conformity and Planning Issues Related
to the IVHS Program.

Date: MAY 1 4 1993

From: Associate Administrator for
Safety and System Applications
Associate Administrator for
Program Development
Washington, D.C. 20590

**Reply to
Attn. of:** HTV-31

To:

Regional Federal Highway Administrators

We have become aware of an important issue regarding the extent
to which activities funded with Intelligent Vehicle Highway
Systems (IVHS) funds from Title VI, Part B, of the Intermodal
Surface Transportation Efficiency Act (ISTEA) are subject to the
conformity requirements of the Clean Air Act Amendments of 1990
(CAAA) and the Transportation Planning and Program Requirements
of the ISTEA. This memorandum is intended to provide guidance on
the issue for the Federal Highway Administration (FHWA) programs
supported with IVHS funds, especially in the following two areas:

1. IVHS Early Deployment Projects
2. IVHS Operational Tests (including the Corridors Program)

It is essential that the requirements of CAAA and of ISTEA be
followed in the development of IVHS plans, programs, and
projects. Following the requirements will lead to effective IVHS
projects that have the support of decisionmakers. Even though
IVHS activities funded under Title VI of the ISTEA by themselves
may not generally be subject to these requirements, the long-term
growth and expansion of the IVHS Program will likely result in
projects that will be subject to these requirements. There will
be instances for project completion, integration, or expansion
where conformity and transportation planning/programming
requirements will apply. Given these situations, there are three
general scenarios in which to consider the extent that the
conformity and transportation planning and program requirements
are applicable.

Scenario #1: Activities Funded Under the Early Deployment Program

Activities funded through the early deployment program are
considered to be comprehensive IVHS planning and feasibility
efforts. In these cases, the activities are not subject to
the conformity requirements because they are for planning
purposes and are not considered to have any air quality
consequences. Similarly, such activities do not need to be

included in the metropolitan or statewide transportation
plans and improvement programs. However, such activities
should be included in the unified planning work program for
the metropolitan area to ensure that they are integrated
into the overall transportation planning process and the
results are considered in the development of plans and
programs for the metropolitan area.

Projects which result after the early deployment planning is
completed, that focus on a particular application, location,
or technology, are subject to the conformity requirements
and need to be included in both the metropolitan and
statewide transportation improvement programs (TIP's). The
projects also need to be consistent with the metropolitan
and statewide transportation plans. These projects, which
may represent the first phase of a long-term effort, must be
subject to a conformity review in order to determine whether
they can be considered neutral.

Scenario #2: A Pure IVHS Operational Test or Corridor Project

If an IVHS operational test or corridor project is of a
strict testing or research nature, it is not subject to the
conformity requirements and does not need to be included in
either the metropolitan or statewide plans and TIP's. This
may include operational test projects which evolve from an
early deployment planning activity. As in Scenario #1, the
activity should be included in the unified planning work
program to ensure integration with the overall
transportation planning process. However, after research
and testing phases are completed, the long-term, wide-scale
installation of tested and proven technologies is subject to
the conformity requirements and needs to be included in both
the metropolitan and statewide TIP's. The project must also
be consistent with the metropolitan and statewide plans.

An additional note on conformity needs to be made under this
scenario. This scenario assumes that no new construction
will be necessary to implement the operational test. If new
construction is necessary, then the conformity requirements
would apply. If construction is required, a determination
would need to be made as to whether the project is
considered neutral and whether a regional or localized (hot
spot) analysis is necessary. For example, the
synchronization of an existing traffic signal system as part
of the operational test would not require a conformity
determination. The construction of new changeable message
signs and/or traffic signals (e.g., at an intersection or
for ramp metering) for the operational test would be
considered a neutral project under the conformity
requirements and not require a regional analysis; however,
it may require a localized (hot spot) analysis.

Scenario #3: An IVHS-Funded Project as a Part of a Larger Federally-aided Project

If the project funded with IVHS funds is part of a larger federally-aided project, then the entire project is subject to the conformity and transportation planning requirements. For example, if IVHS funds are used to support the demonstration of a traveler information kiosk at a mode transfer center or park-and-ride facility that is being expanded with Federal funds, then the entire project, including the kiosk, is subject to the conformity requirements and must be included in both the metropolitan and statewide TIP's. The project must also be consistent with the metropolitan and statewide transportation plans.

The regulations and the procedures that govern the conformity and the transportation planning/program activities are complex and still evolving. We expect that issues and questions will arise that test the requirements and procedures, especially as they relate to IVHS projects. While we cannot attempt to portray every issue or scenario in this memorandum, we hope that this guidance is useful in determining the extent to which the conformity and transportation planning/program requirements apply, with regard to implementing IVHS activities. We strongly encourage your offices to work closely with the States, the metropolitan planning organizations and the local agencies to ensure that these requirements are met and that they will not be a barrier to the implementation of IVHS (or any traffic management) projects.

If you need further assistance with this guidance, or any aspect thereof, the following individuals are available:

* Mr. Wayne Berman, Traffic Management Branch, HTV-31, 202-366-4069.
* Ms. Kathy Laffey, Noise and Air Quality Branch, HEP-41, 202-366-2077.
* Mr. Dean Smeins, Planning Operations Branch, HEP-21, 202-366-0230.

Please feel free to call these individuals.

Anthony R. Kane   Dennis C. Judyck

Memorandum

**U.S. Department
of Transportation**

**Federal Transit
Administration**

Federal Highway
Administration

Subject: <u>INFORMATION</u>: Analyzing Exempt Projects
in the Conformity Process

Date:

FEB 3 1995

From: Director, Office of Planning, FTA
Director, Ofice of Environment
and Planning, FHWA

Reply to
Attn. of:

To: Regional Federal Transit Administrators
Regional Federal Highway Administrators

Recently, several of our field offices have raised the issue of
whether it is permissible to estimate the emissions effects of
highway or transit projects which are listed as exempt projects
in the transportation conformity rule and use the results of this
analysis in determining conformity of the transportation plan and
TIP. The issue also involves whether the projects listed in 40
CFR 51.460 lose their exempt status if an area decides to take
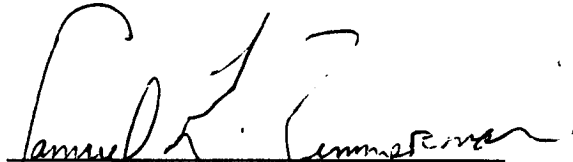emissions reduction credit for them in the plan/TIP conformity
analysis.

EPA's conformity rule does not address this issue directly, but
there is nothing in the rule that would preclude it. While we
continue to believe that exempt projects will have minimal
emissions effects relative to the regional emissions burden, this
issue has gained importance in a number of areas because of the
very small differential between the emissions estimates for the
'build' and 'no-build' cases. For these areas, even minor
emission reductions can be consequential.

We discussed this issue with EPA staff responsible for the
conformity rule and they agreed that it is permissible to
estimate the emissions effects of exempt projects and use the
results in determining conformity of the plan and TIP. The rule
itself notes that the air quality benefits of some small
projects--particularly TCMs--may not be captured in the travel
demand modeling which underlies the regional emissions estimate
for the plan and TIP (40 CFR 51.452(a)). Thus, it allows
'off-model' emissions estimates for such projects in accordance
with reasonable professional practice. These separate emissions
estimation techniques can be used for exempt projects as well.
Alternatively, exempt projects may be folded into the MPO's
network modeling depending on whether the models are sensitive
enough to register any changes in travel due to the project.

Concerning the issue of whether projects lose their exempt status
if an area chooses to do this, DOT and EPA agree that the
projects remain exempt and can proceed in the absence of a
conforming plan and TIP. The strictures in the conformity rule

prohibit regionally significant projects from advancing in order to prevent uncontrolled increases in transportation emissions when conformity cannot be demonstrated. The justification for exempting certain highway and transit projects from the adverse consequences of the conformity process is based on a judgment that these projects have negligible effects and there is no air quality benefit to be gained by blocking them in the event the plan and TIP cannot be found to conform. The concept of exemptions grew out of an understanding that there are projects which are very important for maintaining the viability of the existing system but have very little air quality impact. Thus, the rationale for exempting such projects exists regardless of whether or not they are analyzed in the context of plan/TIP conformity.

We have asked EPA staff to inform their regional offices about this position and have also asked that they address this subject in the next set of questions and answers dealing with interpretations of conformity rule provisions. If you have any questions about this, please contact Mike Koontz at (202) 366-0639 or Abbe Marner at (202) 366-0096.

Samuel L. Zimmerman   Kevin E. Heanue

cc: Kathryn Sargeant, EPA

U.S. Department
of Transportation

**Federal Highway
Administration**

Memorandum

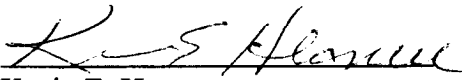|			
Subject:	**INFORMATION:** Timely Implementation of Transportation Control Measures (TCMs)	Date:	FEB 20 1998
From:	Director, Office of Planning Operations, FTA Director, Office of Environment and Planning, FHWA	Reply to Attn. of:	TPL-10/HEP-40 A. Marner, x60096 L. Garliauskas, x62068
To:	Regional Federal Transit Administrators Regional Federal Highway Administrators Federal Lands Highway Program Administrator		

The intent of this memorandum is to clarify how transportation conformity requirements will be applied to transportation control measures (TCMs) within the context of the second set of transportation conformity amendments (40 CFR parts 51 and 93, amended 11/14/95). The second set of amendments allows any TCM in an approved State Implementation Plan (SIP) to proceed regardless of whether there is a currently conforming transportation plan and transportation improvement program (TIP), and regardless of whether the project was once included in a previously conforming transportation plan and TIP. This provision pertaining to TCMs was added to the second set of amendments to ensure timely implementation of TCMs in approved SIPs. The rationale is that these TCMs which are supportive of an area's attainment or maintenance plan should not be delayed as a result of conformity lapse.
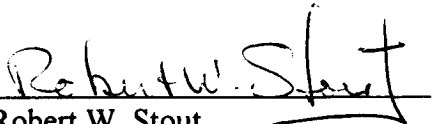
The FHWA and FTA have a responsibility to ensure that projects using Federal funds and/or requiring Federal approvals have been developed through the transportation planning process. The Environmental Protection Agency (EPA) recognizes this in the preambles of the second and third sets of amendments. The preambles specify that EPA will not approve SIPs containing TCMs that have not been coordinated through the transportation planning process or met requirements set forth in Title 23 and the Federal Transit Laws which create the funding mechanisms for TCMs. The second set of amendments does not circumvent the statewide and metropolitan planning requirements in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), or the conformity provisions of the Clean Air Act, which call for all transportation projects to come from the most recently adopted conforming transportation plan and TIP. These plans and TIPs, among other things, must:

- demonstrate fiscal constraint;

- have gone through a coordinated transportation and air quality planning process; and

- meet public participation requirements.

Both the ISTEA and the Clean Air Act Amendments require that the transportation and air quality planning processes be integrated. From a practical standpoint, transportation projects which are proposed to be added to SIPs as TCMs should have met all of the transportation planning requirements (e.g., fiscal constraint, plan conformity, etc.) before they are included in, and approved as part of, the SIP.

Please make sure that State and local transportation and air quality officials are aware of the above requirements for TCMs so that: 1) SIP approvals are not delayed, and 2) FHWA/FTA are in a position to fund and/or approve the TCMs that are included in an approved SIP. We hope that this additional clarification will be useful as questions arise about the TCM flexibility in the recently enacted conformity amendments.

Kevin E. Heanue   Robert W. Stout

Memorandum

Subject:	**INFORMATION**: Planning Horizon for Metropolitan Plans	Date: APR 2 4 1998
		Reply to Attn. of: HEP-20
From:	Associate Administrator for Program Development Associate Administrator for Planning	

To: FHWA Regional Administrators
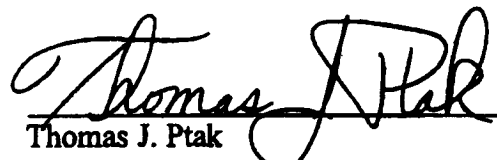FTA Regional Administrators

In recent months, as a product of certification reviews and technical assistance requests, we have had to develop strategies for dealing with several metropolitan areas that adopted transportation plans that do not satisfy the requirement for a 20-year horizon. This requirement is in statute (23 U.S.C. 134(g)(2) and 49 U.S.C. 5303(f)(2)) and the FHWA/FTA joint planning regulations are built around it. Indeed a discussion in the regulatory preamble indicates that it would be prudent to develop plans with 23 to 25-year horizons so that it would not fall below this 20-year threshold at any time.

In the first round of plan updates, prior to December 18, 1994, we allowed the Metropolitan Planning Organizations to utilize less than a 20-year horizon, as long as an area could develop a plan that would satisfy air quality requirements. This phase-in alternative is discussed in 23 CFR 450.336(a), i.e., "If a forecast period of less than twenty years is acceptable for SIP development and air quality conformity purposes, that same time period will be acceptable for transportation planning." All plan updates after this date are expected to comply with a 20-year horizon. The provisions for this requirement can be found in 23 CFR 450.322(a), i.e. "The metropolitan planning process shall include the development of a transportation plan addressing at least a twenty year horizon."

There is no differentiation between attainment and non-attainment areas on the 20-year horizon requirement. This requirement stems from the transportation planning provisions of ISTEA and the conformity process merely relies on it. However, the conformity regulations do make compliance more compelling in non-attainment areas. The only difference between attainment and non-attainment areas is the frequency of plan update; 3-years in non-attainment areas and 5-years in attainment areas.

If you have any questions concerning this matter, please contact either Sheldon Edner, HEP-20, 202/366-4066, or Charlie Goodman, TPL-12, 202/366-1944.

Charlotte M. Adams

Thomas J. Ptak

Memorandum

U.S. Department
of Transportation
**Federal Highway
Administration**

Subject: **INFORMATION:** Travel Modeling Guidance
for Air Quality Analysis

Date: DEC 2 1 1995

From: Director, Office of Environment
and Planning

Reply to
Attn. of: HEP-20

To: Regional Federal Highway Administrators

The validity of travel model estimates used for air quality planning is being intensely scrutinized by a number of interest groups in the environmental community. Also, there is a certain amount of confusion regarding the capabilities of current, in-use models vis a vis modeling requirements for conformity analysis contained in the current Conformity Rule. The purpose of this memorandum is to provide you (and the transportation/air quality stakeholders) with the latest information regarding model validation and reasonable expectations of current travel model capabilities.

Attached to this memorandum are three papers: (1) Checking the Reasonableness of Travel Model Forecasts, (2) Travel Modeling State-of-the-Art, and (3) a TRB reprint of "Simplified and Rational Approach to Address New Modeling Requirements for Conformity Analysis. The first is one of two papers being developed by the Metropolitan Planning Division on the subject of model validation and covers the elements of <u>what constitutes an adequate assessment of the validity of travel models</u>. The paper does not cover the details of "how to do it," but does include the steps that modelers should follow to adequately prove to themselves (and to others) that the model results are reasonable and can be used with confidence. A more extensive paper being developed under contract will include the technical details and steps necessary to perform a model validation. This companion paper should be available spring of 1996.

The second paper attached is a status report of current modeling capabilities and improvements being made to models through various research programs, including our interagency Travel Model Improvement Program (TMIP). This paper was produced to clarify what tools are available now and in use and what tools are still in research and not yet proven. The model application topics are keyed to a number of questions raised by the Environmental Protection Agency (EPA) and others in the environmental community regarding reasonable expectations of current and available models. As progress is made in both the short-term and long-term research, we will provide you with updates. Products of this research will be implemented through our program of technical assistance and training. We are also in the developmental stages with the Texas Transportation Institute for a pilot technical assistance program for new planning methods. A new NHI course "Advanced Travel Demand Forecasting," which presents "tried and true" advanced modeling techniques, will be available in early 1996. We will keep you informed of the progress of these efforts.

The third paper is a reprint of a paper published in Transportation Research Record 1472 and presented at the January 1994 TRB meeting. The paper presents simple, but rational, procedures that States and MPOs can use to address many of the modeling requirements in the current conformity regulations. These relate to speed and travel time estimates. The paper also suggests that trip speeds, rather than link speeds, may be a better way to estimate emissions.

On a number of occasions in the past, we have emphasized the importance of good and complete documentation of model development and validation by the State, MPO, or contractor conducting such work. With the increased interest in good information, it is essential that assumptions used in modeling and the reasonableness of the results be documented so that key assumptions are understood by the public. This documentation should include the assumptions that are made as part of the socio-economic and demographic forecasts. We urge you to ensure that provision for substantive documentation is an element of the MPO's unified planning work program.

Kevin E. Heanue

3 Attachments

CHECKING THE REASONABLENESS OF TRAVEL MODEL FORECASTS

Metropolitan Planning Division, FHWA
July 26, 1995

INTRODUCTION

The ultimate test of any travel demand model is the reasonableness of its base year (or other recent year) estimates and its forecasts for the future. There are two basic groups of tests:

1. Model validation: How capable are the models in replicating the "observed" conditions?

2. Reasonableness of Forecasts: Are the forecasted FUTURE numbers of person trips, trip lengths, mode shares, vehicle trips and vehicle miles of travel (VMT) reasonable in comparison with estimates for the years for which relevant data is available, in comparison with historic trends, and in comparison with forecasts for similar urban areas?

It is good practice for travel modelers to maintain complete documentation of the results of all model checks undertaken, including model input data and assumptions. This is important so that technical personnel from other agencies or public interest groups can easily understand the level of uncertainty inherent in the model forecasts, and so that new technical personnel can easily understand and replicate (if needed) the technical procedures used in the modeling process.

In Sections II and III of this paper, we discuss the types of model output checks that should be made in each of the above categories. For both categories, model inputs must be checked before model outputs are reviewed. We therefore begin the paper (Section I) with a discussion of model input checks.

This paper summarizes key checks that should be made by analysts. We list **WHAT** should be done, not **HOW** the analyst may proceed to perform the checks. FHWA is currently sponsoring development of a "Model Validation and Reasonableness Checking Manual" which will describe the analytcal techniques which may be used to perform the checks.

Travel demand forecasting using the four-step process is central to the analysis and evaluation of transportation system plans and programs in metropolitan areas. Outputs from the process are also used for corridor, subarea, and project-level

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analyses, as well as for regional analyses of air pollutant emissions for air quality planning. Each of the above uses of outputs from the four-step process requires differing levels of accuracy and "refinement" of model forecasts. For example, regional emissions analyses require only **aggregate** checks for accuracy at the regional level; it would be unreasonable to attempt to check and refine link level forecasts (as might be required for project-level or corridor-level analyses).

This paper focuses on aggregate regional accuracy checks. These are the types of checks which may be adequate, for example, to ensure accurate travel demand inputs for emissions analyses to get **regionwide** emissions estimates, such as regional emissions inventories and emissions estimates for regional plan or program conformity analyses. They are **not** adequate checks if a more detailed level of analysis is needed, e.g. for transit ridership estimates in specific corridors, highway segment or intersection traffic estimates or local CO hot spot analysis. FHWA's forthcoming "Model Validation and Reasonableness Checking Manual" (referred to above) will describe both the **WHAT** and the **HOW** (i.e. the analytcal techniques) for other uses of the model outputs which require more detailed levels of analysis.

This paper is not intended to be a comprehensive guide; it only highlights the key checks, reflecting good practice, which should be made to determine the reasonableness of results from the modeling effort. More details on model checking may be obtained through the references described at the end of this paper (see Ref.1 and 2), and from FHWA's forthcoming "Model Validation and Reasonableness Checking Manual", to be referred to as the MVARC Manual in the rest of this paper.

SECTION I: CHECKING MODEL INPUTS

There are two major inputs to travel demand forecasting models. The first is the "networks", which are the primary inputs affected by transportation infrastructure improvements proposed in transportation plans and programs, i.e. the "build" alternative. The second major input is a dataset describing the best estimates of future land use and socio-economic characteristics of the metropolitan area. Reasonableness checking of travel model forecasts must therefore start with these inputs, and then proceed on to checking of outputs from each step of the four-step travel demand forecasting process (i.e. trip generation, trip distribution, mode choice and trip assignment), as described in Sections II and III of this paper.

Network Inputs

The MVARC Manual will discuss detailed procedures for checking the coded attributes of network links (e.g. distance, speed, facility class, area type, number of lanes, etc.). For analyses which involve **updates** to the base network, assuming that the existing base or "no-build" highway network has already been checked, the

simplest check of the accuracy of coding of highway network changes resulting from the "build" scenario is to produce color-coded plots of the "build" and "no-build" highway networks and overlay the build network over the no-build network to visually check the differences. Network links should be color-coded by number of lanes to check for lane additions (or lane reductions, if proposed).

Land Use and Socio-Economic Data Inputs

The MVARC Manual will discuss detailed procedures for checking the base year socio-economic data. Unrealistic forecasts of socio-economic data and land use patterns are a major source of error. For both build and no-build scenarios, "aggregate" checks should seek to answer these questions:

1.   How realistic are projected rates of growth in regionwide employment, population and households, relative to historic rates of growth? Are they in agreement with the latest planning projections made by other public agencies at the metropolitan or State level?

2.   How realistic are forecasts of key variables and their projected rates of change, relative to current (or base year) values and recent rates of change, and relative to other similar metropolitan areas, for: (a) population/employment; (b) population/households; (c) employment/households; (d) vehicles/households; (e) median income/household; and (f) any other key model input variables?

Zonal-level checks should be also be made, seeking to answer these questions:

1.   Are development forecasts consistent with changes in zonal accessibility? Comparison of land use patterns for the build scenario with the no-build scenario is an important check. Traffic analysis zones (TAZs) which gain or lose significant levels of accessibility should be identified for both scenarios, and land use forecasts for these TAZs should be examined to check whether assumed future development patterns are consistent with these changes.

2.   Are development forecasts consistent with plans and zoning ordinances of local jurisdictions? At a minimum, TAZ socio-economic forecasts should be aggregated by local jurisdiction units and/or sub-units and compared with forecasts of the same variables in adopted local plans. (Note: If alternative land use scenarios are being evaluated, consistency will not be needed.)

SECTION II: MODEL VALIDATION

Validation checks are designed to identify differences between model outputs and observed conditions, and the cause of any differences.

At the outset, it should be noted that simply looking at vehicle traffic or transit passenger volumes or aggregate VMT estimates is inadequate. Offsetting errors within the four steps of the process can produce "reasonable" comparisons, even if the underlying travel demand patterns estimated by individual components (i.e. steps) within the model are incorrect. Therefore, it is important that outputs from each step of the model be checked against "observed" data as discussed below, and problems corrected.

"Observed" data to be used in the comparisons may be obtained through local travel surveys, including home interview surveys, transit passenger surveys and counts, and traffic volume counts. Note that for air quality analyses, traffic counts used for comparison must be obtained either from FHWA's Highway Performance Monitoring System (HPMS) or from another locally-developed traffic monitoring system permitted with the concurrence of US DOT and US EPA. The Census Transportation Planning Package (CTPP) is major source of work travel data. For non-work travel data, sources such as the National Personal Transportation Study (NPTS) may be used (see Ref. 3). Comparisons may also be made with observed data from other similar metropolitan areas. As a "reality" check, comparisons may be made with **dissimilar** areas, to check if the differences in travel characteristics are in the "right" direction (e.g. one expects VMT/person in New York City to be much lower than the VMT/person in Houston.)

At a minimum, the following "aggregate" travel characteristics from the travel model should be checked against the types of data discussed in the paragraph above:

(A)   From trip generation output --

    1.   Person trip productions/households regionwide, by trip purpose;
    2.   Work trip productions/employment regionwide;
    3.   How do aggregate regonwide trip productions by purpose compare with aggregate regionwide trip attractions by purpose?

(B)   From trip distribution output --

    1.   Average trip lengths, both in minutes and in miles, by trip purpose.
    2.   What share of total trips, by purpose, are intrazonal?

(C)   From mode choice output --

    1.   What are the shares of trips by auto driver, auto passenger, and transit passenger modes, for each trip purpose?
    2.   What share of total transit trips are destined for the Central Business District (CBD)?
    3.   What share of trips access the transit system by auto?

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(D)   From traffic assignment output--

1.   What share of total vehicle trips were not assigned (i.e. were intrazonal)? What is the share of through trips and external-internal trips?
2.   How do estimates of regionwide VMT compare with estimates based on the most recent Highway Performance Monitoring System (HPMS) data or other locally-developed traffic monitoring system permitted with the concurrence of US DOT and US EPA? (**Note:** If there are differences between base year model VMT and count-based VMT, all estimates from the four-step model are required to be adjusted by the percentage difference before use in estimating regionwide emissions for emissions inventories or for conformity analyses, unless other procedures are approved by USEPA/USDOT; see 40 CFR 93.130.)
3.   What share of total VMT is carried on: (a) freeways and expressways; (b) other principal arterials?
4.   If trips are assigned by time of day, what are the shares of daily VMT in each time period?
5.   How do "congested" travel speeds output from assignment compare with observed travel speeds on the system?
6.   Is there reasonable correspondence between assignment output speeds and network speeds used as input into trip distribution and mode choice?

SECTION III: REASONABLENESS OF TRAVEL FORECASTS

In checking the reasonableness of future travel forecasts, the same step-by-step procedure discussed under model validation should be applied. However, "observed" data is not available to check against. Therefore, the analyst must simply check against the forecasts for other similar urban areas, against historical trends, and against validated model estimates for the base year. This may be done by noting the direction and magnitude of any changes between the base year and the forecast year, and then assessing whether the changes are reasonable given what is known about the metropolitan area and other similar metropolitan areas relative to historical trends, and forecasted changes in socio-economic and land use characteristics, transportation infrastructure improvements and transportation policy changes such as introduction of pricing mechanisms.

A good overall check of reasonableness of forecasts is to simply plot historical trend rates and future growth rates for various model input variables and model outputs, to look for inconsistencies and identify reasons for them. For example, plot regionwide data on:

o   Network inputs -- lane miles, bus miles, etc.

o   Socio-economic inputs -- population, households, workers, vehicles, etc.

o   Model outputs -- person trips, transit trips, auto driver trips, VMT, average system speed, etc.

With respect to transportation policy changes designed to influence travel demand (i.e. TDM or travel demand management), it should be noted that four-step models currently used by transportation planners are incapable of estimating many TDM policy effects. Therefore, "off-model" procedures must usually be employed. The results of such analyses are then married with four-step model forecasts. In checking the results from these procedures, the following questions should be asked:

1.   Are the magnitudes of forecasted changes in numbers of trips, trip lengths or mode shares consistent with the level of commitment of policy-makers and/or employers as measured by the magnitude of incentives or disincentives planned to be implemented and the number of employees to be covered by the policy?

2.   Are the techniques used to make the demand estimates generally accepted practice?

As stated in the begining of this paper, a good overall check of reasonableness of forecasts is to simply plot historical trend rates and future growth rates for various model input variables and model outputs, to look for inconsistencies and identify reasons for them. For example, plot regionwide data on:

o   Network inputs -- lane miles, bus miles, etc.

o   Socio-economic inputs -- population, households, workers, vehicles, etc.

o   Model outputs -- person trips, transit trips, auto driver trips (i.e.vehicle trips), VMT, average system speed, etc.

SUMMARY

This paper has outlined **WHAT** should be done to validate travel models and check reasonableness of forecasts when model outputs are to be used for **aggregate** regional level analyses, such as for regionwide air pollutant emissions analyses. A forthcoming FHWA Manual will provide discussion on what should be done for more detailed types of analyses, as well as **HOW** both aggregate level and more detailed checks may be performed.

In summary, both model validation as well as reasonableness checking of travel model forecasts involve two stages: checking of model inputs (i.e. networks and socio-economic data), and checking of model outputs from each of its four steps. In

model validation, model outputs for the base year are checked against base year "observed" data for the urban area as well as other similar urban areas. In reasonableness checking of travel forecasts, the validated base year model outputs, historical trends and forecasts for other similar urban areas are compared with future year model forecast outputs, in order to check for reasonableness of changes from the base year.

REFERENCES

1.   Supplement to NHI Course No. 15254 "Introduction to Urban Travel Demand Forecasting", Participants' Notebook. National Highway Institute. July, 1993.

2.   Dane Ismart, "Calibration and Adjustment of System Planning Models". Publication No. FHWA-ED-90-015. December, 1990.

3.   Vincent, Mary Jane et al. 1990 NPTS: Urban Travel Patterns. Report No. FHWA-PL-94-018. June 1994.

TRAVEL MODELING STATE OF THE ART

The Clean Air Act Amendments (CAAA) and the Intermodal Surface Transportation Efficiency Act (ISTEA) have placed new requirements on the travel forecasting process. Many new and innovative procedures have been proposed or are under development as a result of these requirements. It is important that practitioners at all levels and the transportation planning and environmental communities have a clear understanding of the latest travel forecasting methods available and in practice today. These groups also need to have reasonable expectations of model capabilities.

This paper provides guidance to state governments, Metropolitan Planning Organizations (MPO), Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) field offices and the Environmental Protection Agency (EPA), on the latest procedures available for implementation and procedures awaiting further research. The procedures discussed here are those which have been brought to the attention of EPA, FHWA or FTA. They do not represent an exhaustive list of all forecasting improvements which are needed or are under consideration.

This paper will be updated periodically as research is completed and becomes available for implementation. The paper addresses availability only and makes no judgement on the applicability or need for the procedures in particular areas. That a procedure is available should not be construed as a recommendation for its use. Each metropolitan area must determine its own modeling needs.

The following procedures will be discussed:

Person trips as the basis for forecast
Travel surveys and data collection
Quantitative land use/Network models
Realistic free flow speeds
Consistency between assignment and distribution
Pricing
Non-motorized travel
Hour by hour analysis and peak spreading
Trip chaining/Activity based forecasting
Long Term Research

1. Person trips as the basis for forecasts - The current process has the full capability of forecasting person trips as a basis for all analysis. Most applications of the current process begin with person trips. In smaller areas vehicle trips may form the basis for forecasting and processes to identify non-auto trips are added as a supplement. For small areas with very low transit shares, this is appropriate.

2. Updated travel surveys and data collection underlying model development and application - In many areas survey data are quite old, having been collected during the 1960s or 1970s. In these instances data may not adequately support model updates. If

a metropolitan area believes that additional data collection is appropriate, the following information is pertinent:

Currently the Department of Transportation (DOT) and Environmental Protection Agency(EPA) are sponsoring the development of a travel survey manual for states and MPOs. This will aid them in providing for better data collection. A course, based on the manual, is being developed through the National Highway Institute. A major component of the Travel Model Improvement Program (TMIP) focuses on research and training needed to improve metropolitan data collection methods for travel forecasting.

Although better data collection techniques are currently available, the time and expense of collecting and analyzing the data (one to two years) mean that the benefits of improved data will not be immediately available.

It is likely that in the future activity based forecasting will replace trip based forecasting. Areas choosing to undertake new data collection should structure surveys so that the results will support both traditional methods as well as activity based methods (e.g. Trip diaries, for example, should record activity at the trip destination).

3. Quantitative Land Use/Network Model - The ISTEA metropolitan Planning Regulations require metropolitan areas to consider the impacts of differing transportation alternatives on land use. One method of doing this is a quantitative land use model.

Approximately 15 to 20 MPOs have implemented this type of land use forecasting procedure. These models are most appropriate in large areas. However, land use models are not needed in areas where adequate alternative methods have been identified.

4. Realistic Free Flow Speeds - In many areas the true free-flow speeds are higher than the posted speeds. Accurately reflecting travel on the network through an assignment model is a matter of adjusting speeds (actually impedances) until volumes are in close agreement. To be realistic, the actual free flow speeds may be used as a starting point, but final speeds after model validation will not always match observed speeds due to the assignment algorithm.

5. Consistency between assignment and distribution - This involves building feedback loops between the assignment models and the distribution models. This is a desirable result. The DOT and EPA have completed a research project addressing technical procedures for building these feedback loops. The report is listed in the references. The report is planned for distribution in the Spring of 1996.

6. Pricing - Traveler responses to pricing include changing route or mode, changing time of day of travel and in extreme cases changing destination or not making a trip.

The EPA has recently published a report on the effects of pricing on travel. This

report gives further guidance on incorporating pricing into the modeling process. (see "Guidance on the Use of Market Mechanisms to Reduce Transportation Emissions", see bibliography attached)

Research is currently underway to develop network analytic procedures to handle multiple criteria, such as time and cost, simultaneously in the assignment process. This work is scheduled for completion in the summer ot 1996.

7. Non-motorized travel (Walk and bike trips) - Current mode choice procedures can have a portion of trips allocated to walk and bike. (See "Short-Term Travel Model Improvements', DOT-T-95-05, Section 2, see bibliography attached). Normally this is handled through the mode choice model.

8. Hour-by-hour analysis and peak spreading - Methods are available to forecast hourly travel. These tend to be empirically based rather than behaviorally based. For a simplified approach, readily available, see "Simplified and Rational Approach to Address New Modeling Requirements for Conformity Analysis" DeCorla-Souza et al., Transportation Research Record 1472 (copy attached). Since these methods are empirically based, they can not reflect the impact of periodic congestion on trip chaining or behavior.

9. Trip chaining/Activity Based Forecasting - Activity based forecasting creates a series of activities to be accomplished in a given period, then links them together to form a trip chain. To be done to best advantage, this requires that the trip chain and activities be forecast by time of day. It also requires that network models be responsive to travel by time of day.

Modest improvements to current forecasting techniques can be made by moving to trip chaining and activity based forecasting. By their very nature these techniques are closer to how actual travel decisions are made. However, the full benefit of moving to this type of forecasting procedure will be realized when it can be combined with network assignment procedures which can continuously simulate traffic by time of day.

It appears that activity based forecasting will likely replace trip based forecasting in the future. Areas which are considering major updates and improvements to forecasting processes should consider moving to an activity and trip chaining approach. However, this change should be part of a comprehensive update, not solely to change the forecasting method. (See comments on data collection under item 2)

LONG TERM FORECASTING IMPROVEMENTS

Methods discussed above focus on improving the existing four step modeling process. Structural flaws in the current process severely limit its ability to more accurately reflect traveler behavior. As an example, it is difficult to forecast or analyze travel by time of day (For a currently available approach using the four step process, see TRR Paper 1472, bibliography attached). This means it has limited capability of reflecting trip chaining, can not analyze travel decisions involving change in time of travel, and can't adequately analyze policies designed to shift time of travel (e.g. peak hour pricing). The

full effects of pricing, peak spreading and trip chaining can not be analyzed using current methods.

In addition, a major component of emissions comes from accelerations and cold starts. The four step process can not predict which trips will be hot or cold starts and can not model accelerations.

In response to the above needs, the DOT, in cooperation with the EPA,has established the TRansportation ANalysis and SIMulation System (TRANSIMS) at the Los Alamos National Laboratories in New Mexico. TRANSIMS was specifically designed to meet the requirements of the CAAA and ISTEA and represents the next generation of travel forecasting techniques. TRANSIMS will have the following components:

1. The forecast of a regional distribution of households.

2. Forecast of a set of activities for each household and a trip chain including time of day) for meeting the activities.

3. A regionwide microsimulation of travel, including both highway and transit.

4. An air quality analysis procedure which predicts emissions from the operating mode of the vehicle (cold start and acceleration are included).

The entire system is expected to be completed in four years, with major subcomponents available earlier.

Simplified and Rational Approach To Address New Modeling Requirements for Conformity Analysis

PATRICK DeCORLA-SOUZA, JERRY EVERETT, BRIAN GARDNER, AND MICHAEL CULP

Recent conformity regulations require air quality nonattainment areas in serious or higher categories to use many model features that are not currently used in the travel forecasting processes of most urban areas. Many of these requirements are related to speed and travel time estimates. For example, travel times used in trip distribution are required to be in reasonable agreement with travel times resulting from trip assignment, which assumes that reasonable speeds are output from trip assignment. In addition, peak and off-peak travel demand and speed estimates are required. The issues relating to each of these requirements are discussed; procedures to satisfy these requirements in a simple but rational way are developed; the potential impacts of the simplified procedures on emissions estimates and conformity tests are investigated. Another issue relating to speeds and travel time is whether trip speeds instead of link speeds should be used as inputs to emissions analysis. In current practice, a link-based approach is used to obtain speed and vehicle activity inputs for EPA's MOBILE5 emission factor model. Nevertheless, a trip-based approach is more rational because it is consistent with the way speed cycles are used to develop emission factors. The impact a trip-based approach might have on the results of conformity analysis is examined through a case study application of a conformity analysis for a typical large urban area.

The role of travel models has expanded as a result of mandates in the Clean Air Act Amendments (CAAA) of 1990 and conformity regulations issued in November 1993 pursuant to CAAA. The conformity rule has defined certain standards that travel models are required to meet for conformity analyses in urban areas that are designated as serious or above nonattainment areas for ozone or carbon monoxide. These urban areas were required to develop enhanced travel modeling capabilities by January 1, 1995. Issues relating to the new modeling requirements are discussed, and procedures to accomplish these requirements in a simple but rational way are demonstrated. The procedures are suggested for use where improved models have not yet been developed or where improved models do not address the issues satisfactorily.

In serious and above nonattainment areas, the conformity rule either requires or encourages many model features that are currently not used in the forecasting processes of most urban areas. The next section discusses the issues relating to features required in two steps of the travel forecasting process: trip distribution and traffic assign-

ment. A later section, Simplified Procedures, discusses proposed simplified procedures to address the issues.

The issues are all primarily related to the accuracy of estimated speeds, an important variable in conformity tests. Specifically, speeds used as input into trip distribution are required to be in reasonable agreement with speeds output from traffic assignment; free-flow speeds based on empirical observation are to be provided on network links for input into traffic assignment; speeds are to be calculated at the link level; and finally, estimates of speed and vehicle miles of travel (VMT) are to be provided for peak and off-peak periods.

Speed is also an important factor in accounting for differences in emissions estimates if a trip-based approach (1) is used for analysis instead of the conventional link-based approach. However, the conformity rule appears to be silent on the approach to be used to calculate average speeds. Therefore, in a later section, Analysis Results, the potential impact of using a trip-based approach for conformity analysis through a case study for a large urban area is investigated. Conformity test results using a trip-based approach are compared with test results using a link-based approach. Also, for the link-based approach, results using link speeds estimated with the simplified procedures were compared with results using "best practice" procedures to estimate link speeds.

CONFORMITY ANALYSIS ISSUES

This section discusses speed-related issues in conformity analysis. These issues are categorized as follows:

- Comparison of assignment output speeds with trip distribution input speeds,
- Peak spreading under congested conditions,
- Assignment input speeds,
- Peak and off-peak speed estimation, and
- Trip-based versus link-based emissions estimation.

Comparison of Output and Input Speeds

The conformity rule requires travel times used in trip distribution to be in reasonable agreement with travel times resulting from trip assignment. It is believed that congestion, in addition to other effects such as shifts in mode use, route choice, and time of travel, causes trips to be sent to closer destinations. Thus, in a "no-build"

scenario, travel distances (and therefore VMT) could be less than in a "build" scenario. Analysts attempting to implement this feature in the forecasting process face two main questions:

- Do travel time inputs to trip distribution measure the same variable as travel time outputs from trip assignment?
- Are current state-of-the-practice analysis techniques capable of producing accurate post-assignment travel times or speeds?

Unfortunately, the answer to both questions is "no" for the current state of the practice for the reasons discussed.

Do travel time inputs to trip distribution measure the same variable as travel time outputs from trip assignment?

The basic problem is that congested speeds output from trip assignment are peak hour (i.e., low) speeds, even if daily trips instead of peak trips are assigned, whereas trip distribution is generally done for daily trips. Congested travel times, which occur mainly during peak periods, should not be used to distribute daily trips—most of which actually occur in off-peak periods. Although people make decisions on which destinations they should go to during peak periods based on peak period speeds, it is irrational to assume that they make decisions on where they should go at other times of the day based on the same peak period speeds. Therefore, average daily speeds are more appropriate for use as input into trip distribution, because average daily trips, not peak period trips, are being distributed. Consequently, average daily speeds should be obtained from trip assignment before valid comparisons can be made to check for reasonable agreement.

The next section discusses a simple way to estimate average daily speeds from assigned daily traffic volumes based on recently completed (FHWA) research (2,3). Note that when urban areas develop advanced state-of-the-art travel models with separate trip distribution models for each time period, estimates of average peak and off-peak speeds will be needed not average daily speeds. The procedures discussed can be extended to calculate such estimates.

Another compatibility problem is that travel times output by traffic assignment are not true travel times but actually "impedances." In other words, they represent more than just travel time: they include other factors that may affect route choice (e.g., preferences by drivers for using different facility classes.) These impedances are developed by adjusting free-flow speed inputs during model calibration to reflect non–time-related factors. Adjustments are made through an iterative process until a good balance of traffic by facility or area type is obtained to match counted traffic. Thus, even in those rare cases where trip distribution may be done by peak and off-peak periods, the impedances output by trip assignment should not be compared with travel times used in trip distribution. Such a comparison would be appropriate only if "true" congested travel times are first estimated using a speed postprocessor. (The next section of this paper discusses a simple procedure to obtain peak and off-peak travel times by hour of the day, directly from assigned daily traffic volumes.)

Are current analysis techniques capable of producing accurate post-assignment travel times or speeds?

The output post-assignment speeds may be inaccurate even if (a) the assignment procedure uses "accurate" relationships of volume-to-capacity (V/C) ratios to speed, including free-flow input speeds based on empirical observation or (b) speeds are corrected through postprocessing. There are two reasons for this. First, most assignment procedures do not incorporate the effects of peak spreading [i.e., the tendency of trip makers to shift from the preferred time of travel (during the peak) to off-peak periods or to shoulders of the peak, when they are faced with peak period congestion.] Therefore, peak-hour volumes are usually overestimated under congested conditions and, consequently, so are V/C ratios. A peak spreading model has been developed in only one urban area—Phoenix, Arizona (4). However, even this model is limited in its application, allowing shifts to the 1-hr periods before and after the peak hour, but not to off-peak periods. This may be sufficient if capacity is available within these 1-hr shoulders of the peak period, but not if the total 3-hr travel demand is close to or exceeds the total 3-hour capacity, as is currently the case in many of the largest urban areas.

The procedures proposed in this paper consider the effects of peak spreading, including not only shifts from the peak hour to its shoulders, but also shifts from peak periods to off-peak periods that may occur under severe congestion. Basically, assigned daily traffic volumes are distributed over all hours of the day based on severity of congestion, using the results of previous FHWA research (2,3).

Second, speeds output from state-of-the-practice postprocessors do not accurately represent true speeds because these postprocessors do not fully consider queueing. For example, a link may have a low V/C ratio but still have a low speed if it is affected by queueing due to a downstream bottleneck (i.e., spillback) or due to queues formed in a previous time period during which demand volumes exceeded capacity. The procedures proposed in this paper develop appropriate techniques to address the issues raised by queueing due to excess demand from a previous time period.

Peak Spreading Analysis Issues

The conformity rule requires models to provide peak and off-peak travel demand and travel time estimates. There appear to be two relevant impacts of time-of-day (T-O-D) analysis. First, emissions models predict higher emissions at the low and the high ends of the speed range [bottoming out at about 88.7 km/hr (55 mph) for HC and CO and at about 48.4 km/hr (30 mph) for NO_x]; therefore separate (low) peak and (high) off-peak speeds should generate higher modeled emissions than a composite peak/off-peak (mid-range) speed, if all other model parameters are the same for peak and off-peak periods. Second, a no-build scenario might show less congestion and emissions if the T-O-D analysis procedure incorporates peak spreading effects (i.e., the tendency of travelers to shift time of travel in response to congestion, as discussed earlier). In other words, under a no-build scenario for which peak spreading is modeled, estimated peak hour speeds may not be as low, and high off-peak speeds may be moderated, reducing relative emissions. On the other hand, under a build scenario, peak spreading effects may not be as significant because of the reduction or elimination of congestion.

Addressing the T-O-D analysis requirement is not easy if congestion influences are to be considered. One option is to perform T-O-D splits in earlier steps of the four-step process, as is done in a few large urban areas. However, in the few urban areas where this option is applied, peak spreading effects are not modeled (4). Instead, observed T-O-D splits are used from base-year home interview surveys to split future daily trips into a.m., p.m., and off-peak trips. Splitting may be done either (a) before trip distribution (i.e.,

daily trip ends are split, or before mode choice (i.e.. person trip tables are split), or before traffic assignment (i.e.. vehicle trip tables are split). To validate the assigned volumes. traffic counts by T-O-D are needed. Because of its complexity and its data requirements - both travel survey and count data are needed by T-O-D), this type of procedure is probably impractical in the future in many nonattainment areas. Also. because the T-O-D factors used are developed from base-year data, they do not reflect shifts in time of travel in the future as a result of congestion, and additional research will be needed to develop models that relate T-O-D splits to congestion.

The procedures proposed in this paper split assigned daily traffic by hour of the day using simple T-O-D and directional distribution procedures that account for peak spreading under congested conditions. yet avoid the complexity of the above T-O-D analysis procedures.

Input Speeds for Trip Assignment

The conformity rule requires input free-flow speeds to be based on empirical observations. The contention is that many urban areas use posted speeds as inputs instead of observed free-flow speeds. Therefore. these speeds are often underestimated because motorists often exceeded speed limits. Lower speeds tend to underestimate NO_x emissions. and on high speed facilities. HC and CO emissions tend to be underestimated as well.

At first glance. addressing this conformity requirement appears simple. It appears that all that is required is to recode the network speeds to match sampled observed free flow speeds on various facility classes. However. such recoding could result in major shifts in assigned traffic volumes so that they no longer match ground counts. This is because modelers often adjust free-flow speed inputs during model calibration to obtain a better match of assigned volumes to ground counts: the rationale is that the adjustments reflect factors other than travel time (e.g.. driver preferences for using some facility types) that affect route choice. In other words. free flow speeds used as input in many assignment models are not meant to be accurate speeds but only calibrated impedance parameters. Using a postprocessor to get more accurate average daily and hourly speeds appears to be a more reasonable approach to address the intent of the conformity rules.

The procedures proposed in this paper do not attempt to adjust input free-flow speeds but instead focus on estimating output speeds more accurately using a postprocessor. which accounts for empirically observed free flow speeds as well as peak spreading and queueing phenomena.

Peak and Off-Peak Link Speeds

Along with estimates of peak and off-peak VMT, the conformity rule requires estimates of peak and off-peak speeds. The conformity rule also implicitly requires estimates of traffic speeds and delays to be based on estimates of traffic volumes and capacities on network links.

A common practice is to average speeds by functional class. Such average speeds tend to be in the middle of the speed range where emission factors are lowest for HC and CO and not usually very sensitive to small differences in speed.

The requirement for more accurate link speeds has been addressed in some areas using sophisticated approaches based on

the *Highway Capacity Manual* (HCM (5) with default input parameters (e.g.. signal cycle lengths) by functional class. The Houston-Galveston Area Council's procedure (6) is a good example. An intermediate level of detail uses relationships of V/C ratios to highway level of service (LOS) and LOS to speed from lookup tables (7). However. none of the current approaches can capture the effect of queueing from a previous time period. as explained earlier.

The procedures outlined in this paper may be used to obtain hourly speeds that incorporate vehicular delay due to queueing from a previous time period. A simple postprocessor was developed to obtain queueing-sensitive average daily speeds. and the procedures are being extended under FHWA sponsorship to obtain average hourly speed estimates directly from assigned daily traffic. using relationships that vary by facility type and area type.

Trip-Based Versus Link-Based Analysis

In current practice. estimates of travel activity (i.e.. VMT) and speed are link based. However. emission factors in EPA's MOBILE model are based on data that represent trip travel characteristics instead of link-level travel characteristics. In the Federal Test Procedure. which is the basis for developing baseline emission factors. "bags" of pollutants are collected from entire trips about 20 min long. Therefore. developing travel characteristics for limited segments of the highway network is inconsistent with the base from which MOBILE factors are developed (i.e.. entire trips.) In particular. average speeds on which MOBILE factors are based represent speed cycles for an entire trip. not speed cycles on any specific link. (This problem could be solved by developing emission factor models based on facility type-specific speed cycles. The California Air Resources Board is attempting to develop such models for freeways and arterials.)

A previous paper (1) describes a method to derive VMT and average speeds based on trips instead of links. The application of the procedure to this case study is described in a later section. Case Study.

SIMPLIFIED PROCEDURES

Figure 1 provides an overview of the simplified procedures proposed in this paper to address the speed-related conformity analysis issues discussed in the previous section. The top part of Figure 1 indicates the process used to estimate average daily speeds from assigned traffic volumes. which are used to check for reasonable agreement between output speeds from trip assignment and speeds input into trip distribution. The bottom part of Figure 1 indicates postprocessing procedures to obtain travel demand estimates by time-of-day that are sensitive to peak spreading and obtain peak and off-peak speeds that incorporate peak spreading and queueing effects. The procedures are discussed in greater detail in the following subsections.

Average Daily Speeds

The procedures rely heavily on recent FHWA research (2,3) to develop average daily speed determination models based on data for freeways and signalized arterials. The procedures developed in the research effort to estimate average daily speeds involve three steps:
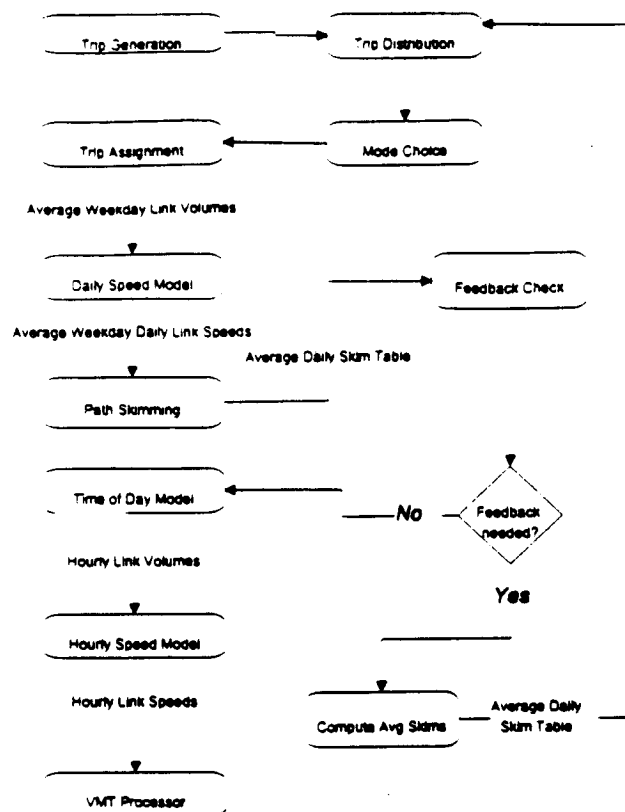
FIGURE 1 Travel analysis procedures.

1. Daily traffic is first split into volumes by hour and direction.
2. Hourly directional traffic is used to estimate hourly traffic delays, and
3. Delays are accumulated over all hours to obtain total delays over a 24-hr period. Average daily speeds are then calculated.

For Step 1, the research used data from automatic traffic recorders to develop T-O-D distribution profiles of directional link traffic for various levels of congestion. Congestion was measured in terms of the ratio of average daily traffic to link capacity (ADT/C). ADT was measured on either an annual average basis or an average weekday basis, AADT or AWDT.

For Step 2, the research used traffic simulation models, i.e., NETSIM and FRESIM (8), and the demand estimates by hour (generated by the T-O-D distributions) to simulate queueing delay effects by hour for typical freeways and arterials operating at varying ADT/C ratios.

In Step 3, these delays were accumulated over all hours of the day and aggregated with travel times at free-flow speeds to obtain total daily travel time and average (VMT weighted) daily speeds.

The study developed empirical relationships to estimate hourly link volumes and total daily delay for varying ADT/C ratios (2). These equations were later refined (3). The refined equations developed to estimate average daily speed for arterials are

$$\text{AADT/C} < = 7: \quad DR = (1 - e^{-x.2+4})(68.7 - 17.7x)$$
$$\text{AADT/C} > 7: \quad DR = (1 - e^{-x.2+4})[192.6 - 14.4(x - 7)$$
$$- 1.16(x - 7)^2] - 0.160(x - 7)^2$$

and the refined equations developed to estimate average daily speed for freeways are

$$\text{AADT/C} < = 8: \quad DR = 0.0797x - 0.00385x^2$$
$$8 < \text{AADT/C} < = 12: \quad DR = 12.1 - 2.95x - 0.193x^2$$
$$\text{AADT/C} > 12: \quad DR = 19.6 - 5.36x - 0.0342x^2$$

where

x = AADT/C,
DR = daily vehicle hours of delay 1,000 VMT,
n = signals per mile,
AADT = average annual daily traffic, and
C = highway capacity (vehicles/hour).

For this case study analysis, the earlier unrefined equations to estimate average daily speed were used. Zone-to-zone travel time skims were then developed using these speeds and compared with skims used as input into trip distribution.

T-O-D Traffic Splitting

The T-O-D model uses average daily assigned traffic as input. Daily traffic is split into traffic for each hour of the day using profiles of the hourly distribution of traffic, which vary by ADT/C ratio. Thus, peak spreading effects are automatically incorporated. Examples of the profiles are shown in Figure 2 and in Table 1.

Peak and Off-Peak Speeds

The simplified procedures for estimation of hourly speed presented here are not yet fully developed and computerized. Research sponsored by FHWA is underway to extend the basic procedures used to develop the average daily speed determination models to provide hourly speeds. The procedures will use the hourly delay estimates generated for the purpose of developing the average daily speed equations to calculate hourly speeds. Information on free-flow speeds will be combined with hourly delay estimates to obtain average hourly speeds. Because free-flow speeds vary by facility type and area type, separate delay relationships (based on ADT/C ratios) will be developed by facility type and area type.

CASE STUDY

This case study had four objectives:

1. To demonstrate how the above simplified procedures could be applied in a real-world situation—compute from assigned daily traffic (a) peak and off-peak traffic volumes and (b) average daily link speeds. (Note: The demonstration of the procedures for estimating average peak period and off-peak link speeds is awaiting completion of FHWA research on hourly speed models.)
2. To compare link-based emissions estimates using average daily link speeds (estimated with these simplified procedures) with estimates using best practice speed estimation procedures. (Note: In best practice, emissions are estimated using average peak period and off-peak link speeds.)
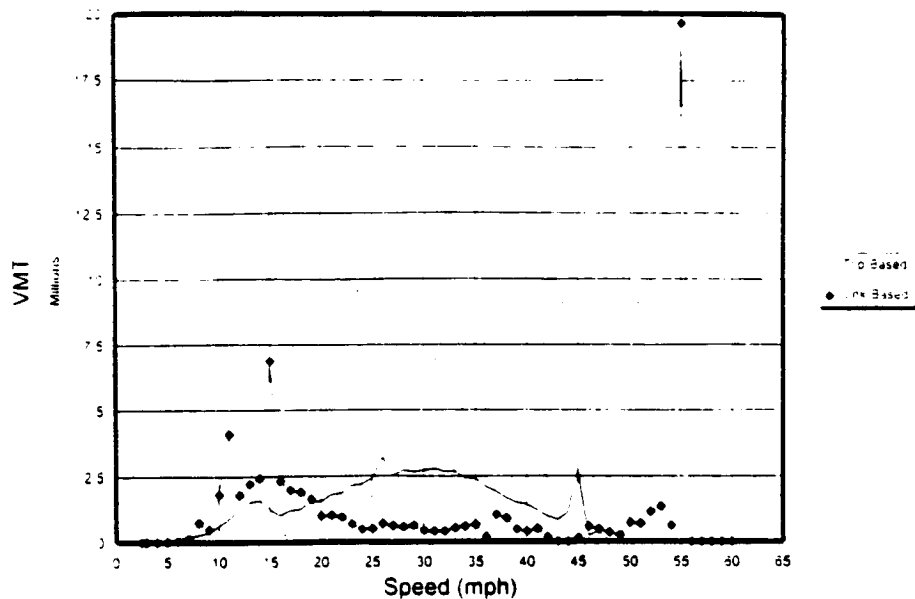
FIGURE 2 Distribution of total daily trip- and link-based VMT for build.

3. To investigate the potential impact of using these simplified procedures for conformity analysis by comparing conformity test results that used the simplified procedures with test results that used best practice speed estimation procedures. (Note: Emissions estimates in both cases would be link based.)

4. To investigate the potential impact of using a trip-based approach for conformity analysis, by comparing conformity test results that used a trip-based approach with test results that used a link-based approach. (Note: Speed estimates in both cases would be average daily link speeds using the simplified procedures: the only difference would be that in the trip-based approach speeds would be averaged over the entire trip instead of on individual links.)

The case study analysis was conducted for a large urban area (Baltimore, Maryland). The case study involved a conformity test for a "theoretical" financially unconstrained long-range plan that would return highway levels of service to those existing in 1990. To focus on the effects of differences in average speed estimates under the various approaches, the no-build network assigned daily traffic volumes (and VMT estimates) were used for both the build and no-build alternatives. Note that the use of feedback loops in travel models generally has the effect of lowering VMT estimates for the no-build alternative (relative to the build alternative), as a result

of shortening of trip lengths (distances) by the trip distribution model under congested conditions. Occasionally, this effect may be offset by increases in VMT because of drivers seeking (longer) uncongested routes in trip assignment.

No-build network average daily speeds were estimated using daily traffic volumes from the no-build network traffic assignment. Build network average daily speeds were estimated using base year 1990 network assigned traffic volumes and capacities because it was assumed that the build network would return ADT/C ratios to 1990 levels. The following subsections discuss the application procedures used for the case study.

Postprocessing Link Data

Postprocessing of assigned daily traffic involved developing.

* Average daily speeds, using the simplified procedures outlined in this paper,
* Peak and off-peak traffic volumes using the simplified procedures, and
* Peak and off-peak speeds using best practice procedures.

The postprocessor used for this study was developed as a stand-alone module outside the travel demand model. Link characteristics were passed between the demand model and the postprocessor using an ASCII data base. Extracting, post processing, and recompiling the network required approximately 10 min of computer time. The post processing procedures will be discussed in greater detail.

Average Daily Speeds

Average daily speeds were calculated as described previously in the section, Simplified Procedures.

TABLE 1 Daily Emissions for Baltimore Study Area

		2010 NO-BUILD		2010 BUILD	
	VMT	EMISSIONS(tons)		EMISSIONS(tons)	
		HC	NOx	HC	NOx
TRIP-BASED:	68,173,072	149.16	117.09	147.47	117.35
LINK-BASED: (Avg Daily)					
NETWORK LINKS	63,694,486				
INTRAZONAL	4,478,576				
TOTALS	68,173,072	162.21	126.56	157.48	126.42
BEST PRACTICE: (Sum of Periods)					
NETWORK LINKS	63,687,736				
INTRAZONAL	4,485,336				
TOTALS	68,173,072	143.22	126.37	138.77	126.74

Estimating Peak and Off-Peak Traffic Volumes

The postprocessor estimated hourly link volumes using AADT/C relationships developed for the average daily speed determination models (2). Peak and off-peak hours were identified based on the percentage of daily traffic in each hour. and total traffic was then aggregated for three time periods: a.m. peak. p.m. peak. and off-peak.

Peak-direction information was unavailable within the network data for this case study urban area. However, this information was needed for the best practice speed estimation procedures. Therefore. links with odd A-node numbers were assumed to have an a.m. peak direction and links with even A-node numbers a p.m. peak direction. This provides a reasonable estimate of peaking effect and does not affect estimates of aggregate link emissions (i.e.. total emissions from traffic in both directions).

Peak and Off-Peak Speeds

The simplified procedures outlined earlier could not be used. pending completion of the FHWA-sponsored research (also described earlier) to extend the average daily speed determination models to hourly speed estimation.

Currently best practice. peak. and off-peak speeds are estimated using HCM procedures. Because one case study objective was to compare emissions estimates that used simplified procedures with emissions estimates that used best practice. a postprocessor was developed to incorporate best practice procedures for estimating hourly speeds. The procedures are complex because they require signal locations to be identified and coded. instead of using defaults by facility type and area type. as proposed in the simplified procedures.

The procedures consist of two submodels. one for freeways and one for arterials. The procedures are derived primarily from the HCM procedures and estimate link speeds by hour of the day. Although the HCM procedures do not explicitly model delays due to queueing in a previous hour or spill-back. they predict through delays on simple signal approaches as well as on freeway links for reasonable V/C ratios (i.e.. less than 1.3). Because the input hourly traffic was obtained from the T-O-D model described (which incorporates peak spreading effects). reasonable V/C ratios were estimated on almost all links.

The freeway model used the updated HCM saturated flow rate of 2.200 vphpl (9). The speed limit was used as the average free-flow speed for V/C ratios of up to 0.70. A crawl speed of 12.9 km/hr (8 mph) was used for V/C ratios over 1.1. The regime from 0.70 to 1.1 was assumed to be linear.

The arterial model was substantially more complex. Previous studies have shown that traffic control (i.e.. signal and stop sign density) governs the travel impedance on signalized arterials (2.10.11). The HCM uses signal approach through delay and arterial running speed to estimate average hourly arterial travel times and speeds. This requires data on signal locations. arterial class. access intensity. and approach capacity. Although these data were not explicitly contained within this case study data base. much of it was inferred from available information, and the remaining elements were synthesized. For example. because data on actual signal locations were unavailable. signal density assumptions were made on the basis of area type. facility type. and segment length. Arterial class and running speed were estimated on the basis of area type. segment length. speed limit. and facility type. Approach capacities

were estimated on the basis of earlier work by the Florida Department of Transportation (12).

Applying the Trip-Based Approach

Figure 3 presents the procedures used to apply the trip-based approach. The Baltimore travel models estimate trips for six trip purpose categories and for a 24-hr period. Using national survey data from Nationwide Personal Transportation Study (13). estimates of operating mode percentages (i.e.. cold and hot start percentages) and vehicle mix for each trip purpose were derived for the trip-based approach. Trip length (i.e.. duration) distributions were obtained for each trip purpose from the travel models. based on post-assignment average speeds. Average daily link speeds were estimated as described earlier.

Emissions estimates were based on daily VMT and average daily speeds. The assigned networks with postprocessed estimates of average daily link speeds were skimmed to obtain zone-to-zone travel times and distances. which were then used to obtain zone-to-zone average speeds. Zone-to-zone daily vehicle trips were obtained from daily vehicle trip tables by purpose output from the mode choice model. Zone-to-zone VMT was computed as zone-to-zone vehicle trips times zone-to-zone distance. A previous paper (1) discusses these procedures in greater detail.

Applying the Link-Based Approach

Two different methods were used to estimate daily emissions with the link-based approach: (a) using daily VMT and average daily
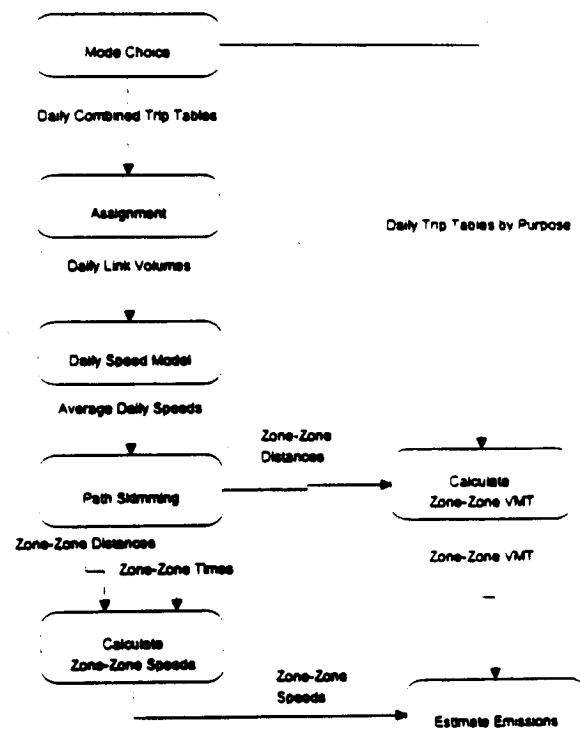
FIGURE 3 Emissions estimation procedure for trip-based approach.

speeds estimated using the simplified procedures and (b) using peak and off-peak VMT estimated using the simplified procedures, along with corresponding peak and off-peak speeds estimated using best practice.

Daily link-based VMT was developed from the "combined purpose" traffic assignment. To ensure consistency with travel characteristics developed for the trip-based approach, the cold and hot start percentages, vehicle mix, and trip length (i.e., duration) distribution were obtained by computing weighted averages of the parameters used by trip purpose in the trip-based approach.

Because this case study focused on evaluating the sensitivity of emissions estimates to differences in speed estimation procedures, operating mode percentages were not varied by time of day for the peak and off-peak application, although recent research by Venigalla et al., in another paper in this Record, could be used to develop such inputs in future work. Vehicle mix was not varied by time of day either.

ANALYSIS RESULTS

Table 1 compares HC and NO, emissions estimates for the no-build and build alternatives. It should be noted that Baltimore-specific MOBILE settings were not used for technology parameters (i.e., the emission factors used do not reflect inspection and maintenance (I/M) programs). Thus the emissions estimates developed are not directly comparable to those developed for inventory or other regulatory purposes.

Table 1 indicates that the three approaches, each based on a different speed estimation procedure, result in significant differences in the amount of HC emissions estimated for the no-build alternative. Similar differences are observed for the build alternative. The table indicates that HC emissions are substantially higher if the link-based approach is used with average daily speeds estimated using the simplified procedures. Although the trip-based approach (with average daily speeds) shows lower emissions for HC, they are still higher than emissions estimated with the best practice link-based "sum of periods" (i.e., peak and off-peak periods) approach.

Figures 2 and 4 present profiles of VMT by speed for the three approaches. The profiles suggest the reasons for the significant differences in emissions estimates. In Figure 2, the trip-based approach is compared with the link-based approach. Even though average trip speeds for the trip-based approach are derived from the same link speeds (i.e., based on links on the assigned paths between zones), the trip-based approach results in a concentration of VMT in the center of the speed range, where HC emissions tend to be lower. VMT under the link-based approach tends to concentrate in the low and high ends of the speed range.

Figure 4 compares the simplified procedures, using the link-based approach, with best practice procedures. The best practice procedures result in significantly fewer VMT in the low end of the speed range below 24.2 km/hr (15 mph), where emission factors tend to be highest. The main difference in the two procedures is that queueing delay is handled more thoroughly in estimation of speeds with the simplified procedures, leading to the significantly higher estimates of low speed VMT.

Table 2 presents the results for the build versus the no-build conformity tests for HC and NO,. The comparison indicates that the build alternative passes the HC test regardless of the approach used. However, the build alternative fails the NO, test if the trip-based approach is used, although it passes the test if the link-based approach is used with either the simplified procedures or best practice procedures. In other words, for the NO, test, passing the test depends on which approach is used.

CONCLUSIONS

Serious and above nonattainment areas will need to address specific modeling requirements in the conformity rule issued in November 1993. This paper has developed simple and rational procedures to respond to these needs and demonstrated application of the procedures to the conformity analysis for a large urban area.

The main contribution of this effort is the operationalization of simplified procedures for time-of-day analysis and estimation
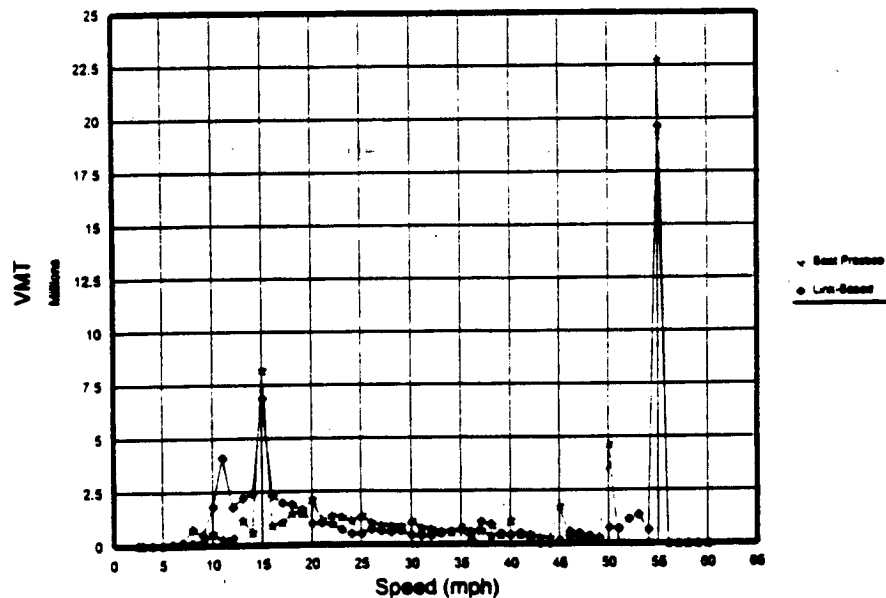

FIGURE 4 Distribution of total daily best practice and link-based VMT for build.

TABLE 2 Conformity Test

	EMISSIONS (tons/day)		DIFFERENCE		PASS
	2010 BUILD	2010 NO-BUILD	Absolute (tons)	Percent	
HC					
TRIP-BASED	147.47	149.16	1.69	1.13%	YES
LINK-BASED	157.49	162.21	4.72	2.91%	YES
BEST PRACTICE	139.77	143.22	3.45	2.41%	YES
NOx					
TRIP-BASED	117.35	117.09	-0.26	-0.22%	NO
LINK-BASED	126.42	128.66	2.24	1.74%	YES
BEST PRACTICE	126.74	129.37	2.63	2.03%	YES

of average daily speeds. FHWA is undertaking further research to extend the capability of the average daily speed determination models to estimate hourly speed.

The paper also demonstrated that using the simplified procedures. which handle queueing delay more thoroughly. can result in significantly higher emissions. In addition. using a trip-based approach to perform emissions analysis can have a significant impact on the results of conformity tests.

The contradictory conformity test results with alternative approaches suggest that further investigation is necessary to determine the cause of these differences and to determine which approach would provide a better conformity test. Further investigation is also needed to evaluate the effect of using peak and off-peak analysis procedures with the trip-based approach (including varying operating mode and VMT mix by time-of-day).

ACKNOWLEDGMENTS

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